Annual Technical Progress Review of the LANL npdγ Experiment

November 5-6, 2002
Los Alamos National Laboratory

Summary

A Technical Progress Review of the LANL npdγ Experiment was held on November 5-6, 2002 at Los Alamos National Laboratory. The DOE NP division organized and conducted this year's annual technical review and intends on continuing these DOE reviews until the project is complete. The members of the review committee were Dr. Vincent Cianciolo (ORNL), Dr. Roy Holt (ANL), Dr. Hal Spinka (ANL), Professor John Wilkerson (University of Washington), Professor Christopher Gould (North Carolina State University), Dr. Eugene Henry (NP DOE) and Dr. Jehanne Simon-Gillo (NP DOE-chairperson); Dr. Bradley Keister from the National Science Foundation attended as an observer.

This experiment proposes to measure the parity-violating asymmetry of the correlation between the direction of emission of the gamma ray and the neutron polarization in the reaction npdγ. The measured asymmetry is related to the weak isovector pion-nucleon-nucleon coupling, which has yet to be measured with a high accuracy. Its precise measurement can yield information about weak NN interactions and low energy QCD, such as the effective strength of quark-quark neutral currents in QCD. The project is separated into two sections, the experiment construction and the beam line construction at the LANSCE facility at LANL. David Bowman is the spokesperson of the experiment and Seppo Pentilla is the Project Manager. The agreed upon funding profile is as follows:

	Prior yrs	FY01	FY02	FY03
Beamline:	205	1200	503	0
Experiment:	83	736	399	98

All capital equipment funds have been allocated.

The primary findings of this review, based on the individual panel reviewer evaluations and the information obtained in the presentations and subsequent discussions, are as follows:

- The science of the experiment remains compelling. Projected losses in sensitivity place the planned measurements at risk, depending on the magnitude of the parameters under study.
- The experiment has made impressive technical progress in the past year. The ability of the project to shield itself from the stray field of a recently installed superconducting magnet in the neighboring flight path 11 is a serious technical issue. Project, P Division, and LANSCE managements should generate a mutually acceptable plan to resolve the FP11 and FP12 magnet shielding issue.
- The project is experiencing schedule delays; the end of the construction project is now estimated to be August 2003, and the proposed experimental program is now through December 2006. More emphasis on schedule is needed.
- The project is currently within budget. The collaboration and LANL management have done an excellent job in covering cost growths in the past.

- The project manager is doing a very good job in utilizing project tracking tools and managing the project. More emphasis on schedule is needed. Interactions between the management of this project and LANSCE management need to improve. The project assembly and installation schedule should be integrated into the LANSCE facility schedule.
- A commissioning manager, whose responsibility is to optimize and coordinate the very aggressive installation and commissioning plan, should be appointed.
- Given the projected time scale to complete this project, coupled with a potential future use of the npdγ apparatus, this experiment will be included in any forthcoming comprehensive review of current and future fundamental neutron physics experiments.

Excerpts from the reports of the review panel members regarding these findings as well as others are provided below in their responses to the review criteria they were asked to address.

Reviewers Comments:

The merit and significance of the neutron project scientific programs and hardware upgrades:

"Nuclear parity violation remains one the intriguing mysteries of low-energy nuclear physics. A precise measurement of gamma-ray asymmetry of polarized neutron capture on para-hydrogen should both help address this question as well as provide important guidance on the weak NN meson-exchange process. In the context of the overall US nuclear physics program, the answers to such questions will likely not have the far reaching and long lasting impact of say discovering the quark-gluon plasma or uncovering neutrino properties, but nevertheless such research is definitely warranted.

Unfortunately, the LANL npdγ collaboration now forecasts that their measurement will have a factor of three less potential sensitivity then originally predicted in their proposal (due to the reduced beam, reduced moderator brightness, etc.). This is certainly a disappointment, since the revised sensitivity of $1.5 * 10^{-8}$ approaches the lower range of the theoretically predicted values. One hopes that their estimates of systematic uncertainties have not been similarly optimistically underestimated. An additional potential problem with this reduced sensitivity is that the longer time required to obtain statistics may result in increased systematic uncertainties, simply from changes in the local environment and the detector system over the longer running time of the experiment.

It is too early to answer the question of a long time physics program on this future beam line. Such a question needs to be evaluated based on the effectiveness of the npdγ experiment and in the context of the overall future US program and the availability of other fundamental neutron physics sources and beamlines."

"The measurement of the parity violating asymmetry, A_γ, in the $np \rightarrow d\gamma$ reaction is a high priority experiment, affecting the value of the $\Delta I = 1$ hadronic weak interaction coupling (H_π^1) and the interpretation of parity violation measurements in ^{18}F and other nuclei. Differences between existing values of H_π^1 from other reactions are about ten times the presently estimated error for this experiment. A number of good follow-on experiments can also be performed in this beam line / flight path. For these reasons, the project needs to be completed in a timely fashion."

"The scientific motivation for p(n,γ)D was compelling at the time of its initial proposal and continues to remain so. The problem regarding the value of f_π is still outstanding and has strong theoretical interest and motivation. It is very important that the experiment succeed in measuring f_π at their proposed goal. The collaboration is composed of very high quality scientists who are leaders in the field and have a proven record of accomplishment. I fully expect that they will do what is necessary to see that p(n,γ)D is successful. All subsequent comments should be viewed within that context.

There is some concern about loss in sensitivity from the proposal due to source issues. With the experiment already predicted to require almost 4 years of data taking, there is no room for any additional losses. Since there is no beamline and no measured flux numbers, one is forced to rely on the predictions of calculations. They seem sound, but it is not uncommon for additional small losses to accumulate, resulting in final throughput being notably less than originally anticipated. One does not want to see a final sensitivity less than 1.5×10^{-8}. If f_π is small, as some have argued, the statistical significance of this measurement diminishes."

"The npdγ collaboration seeks to make an accurate measurement of f_π, the major term in the hadronic weak interaction, by measuring the gamma-asymmetry in neutron capture on para-hydrogen. Current experimental results are in disagreement and this experiment will provide the definitive answer. The expected count rate has been reduced by a factor of eight since submission of the proposal, thus increasing the required running time by that same factor or reducing the ultimate sensitivity of A_γ measurement by $\sqrt{8}$. This reduction was primarily a result of the fact that the LANSCE beam power has not achieved expectations and the fact that the moderator brightness is significantly less than calculated. Finally, there were several optimistic assumptions about the experimental apparatus. However, the committee noted that simply observing that f_π is large (which can be done in a year even with the reduction in the expected count rate) is critically important."

"This experiment is the centerpiece of a renewed effort to solve a fifty year old question - what is the strength of the weak force between nucleons. Conflicting results for the size of the weak coupling associated with pion exchange (from experiments in heavy nuclei like F, Cs, U, Th) have lead to an emerging consensus that a precision set of measurements in A<5 nuclei is needed to finally pin down the strength of the hadronic weak interaction. Parity violating effects in few nucleon systems are exceptionally small (10^-7 or less), and extraordinary precision is required to make definitive measurements. The collaboration has developed many clever solutions to the problems of understanding systematic errors, particularly taking advantage of the time-of-flight information in a pulsed beam. The originally proposed sensitivity ($0.5*10^{-8}$) of npdγ allowed for a 10% measurement of h-pi at its (small) DDH value in a year of running. The loss of a factor of eight in flux (associated in part with reduced beam intensity and moderator brightness) means this sensitivity goal is no longer attainable at LANSCE. However, if h-pi is large, as suggested by the anapole measurements in Cs and the TRIPLE parity violating measurements in heavy nuclei, then an interesting and significant result can emerge in just a year of running, possibly even by the end of 2003."

"This experiment addresses a very fundamental issue in parity violation in the strong interaction. This experiment is believed to be an excellent way to measure the long-range or pion exchange part of the parity violating strong interaction. Since n-p capture is a relatively simple nuclear reaction, it is believed to provide a better measure than the data already available for ^{18}F or the anapole moment in ^{133}Cs. It is disappointing that the figure of merit for the experiment has slipped by a factor of eight from the original proposal. Nevertheless, the experiment still has the promise to confirm whether the pion

contribution is large as suggested by cesium or small as expected from the fluorine experiment.

Two other experiments were presented as future possibilities: correlation and asymmetry parameters in neutron decay and EDM of the neutron. Since these experiments are relatively far in the future, they should be included in the upcoming general review of fundamental neutron physics."

The technical status of the neutron projects:

"The technical aspects of the project are in hand and under control with the significant exception of the issue of magnetic field interference from the superconducting solenoid on FP11. This is a critical problem. Unless appropriate shielding is in place, it will be impossible to take any useful data while this magnet is energized."

"There was significant technical progress on all subsystems for the experiment. Nevertheless, it appeared that the entire project was about a year behind schedule. It was most notable that the components of the beam line subsystems appeared to be ready to install, but require LANSCE technical resources for installation. The most obvious technical issue for the experiment is the stray field from the superconducting magnet on beam line 11. This poses a substantial threat to the experiment that the Laboratory should solve immediately by both administrative and technical means. This issue has significantly delayed the construction of the cave for the experiment, which in turn, has induced delay in several subsystems. The cave is a critical path item.

It was disappointing that none of the experiment subsystems with the possible exception of the spin flipper appeared to be ready for installation even with the one-year slip in the schedule. The readiness of the experiment for installation would create additional incentive for the Laboratory to install the experiment. Key items which should receive special attention are the timely procurement of the fully-tested pre-amps and amplifiers and a fully-tested and safety-approved non-magnetic LH2 cryostat with a gas-handling system. It appears that there are no other serious technical issues that are not covered by the collaboration's plans."

"Most of the individual components have been developed and initial tests performed. However, there is at least one critical system, the LH2 target that is still in the fabrication stage. Given the required operational safety requirements and reviews, any delays of the target may result in subsequent delays of the project. Essentially none of the important integrated system tests have been done. To do these tests requires assembling the detector and target in the final experimental cave. The assembly and testing will require significant resources and effort as well as careful coordination. Any unexpected problems that turn up during this process, and there will likely be at least a few, will almost certainly result in delays.

Of considerable concern is that construction of the needed experimental cave has been delayed while a problem with magnetic interference of a nearby instrument, the FP11A

superconducting magnet, is resolved. At some level, given the amount of resources devoted to this project, it is simply astounding that the facility (LANSCE and LANL) allowed this problem to arise. All parties (npdγ, P-Division, and LANSCE) must work together to resolve the issue. On a positive note, it seemed at the time of our meeting that management understood this problem and was willing to work together to resolve the issue. The collaboration seems to have rejected active shielding cancellation options, although such a method has recently been successfully utilized at the NIST fundamental neutron beam line in Gaithersburg."

"Many components of the flight path (FP12) and experiment are constructed and either installed or ready to be installed. Considerable testing has occurred in the laboratory and in three previous runs with beam. The integrated shielding for FP12 and FP13 has been successfully completed, allowing savings in costs and time. The measurement of parity violating asymmetries in La and Cl targets is planned throughout the np→dγ data taking period to search for changes in the operation of the experimental hardware; this has already been demonstrated in a test run with some of the final apparatus, and is strongly endorsed.

A potentially serious problem is the fringe field from a nearby high field superconducting magnet in FP11. This magnetic field could produce significant systematic errors, especially since the field may be ramped up and down at times during the np→dγ data taking runs. The collaboration, P Division and LANSCE managements are considering options to minimize the impact of this fringe field, and they are strongly urged to come to an agreement soon. While an administrative solution (scheduled periods with the FP11 magnet off) would be acceptable in 2003 and perhaps 2004, a technical solution is required before 2005 if the superconducting magnet remains in FP11.

There are a number of minor technical concerns: a) The ^{3}He polarizer has the advantage of a low polarizing field compared to a super mirror. Long term operational experience is not available from a previous experiment (the collaboration plans to test the polarizer for several months at LANL). b) The liquid hydrogen target needs to be completely assembled and tested, plus pass additional reviews. It appears to be on or close to the critical path for the project. c) Some of the electronics for the CsI(Tl) detectors have not been finalized. d) The role of LED's on the CsI detectors for monitoring gains should be tested, as some LED's exhibit ~±10% drifts in output. e) The addition of some status bits to the data in the VME crate located in the cave would add a further level of security to the data collection. In particular, information on the neutron spin and guide field directions would be useful additions."

"The technical progress appears to be proceeding on all of the work packages, and it does not appear that there are any potential "show stoppers." There is still quite a significant amount of work that needs to be done, but it seems to fall into the categories of construction/assembly/testing rather than R&D. The essential components of the experiment have been thought out and the path to realizing them is clear. One shouldn't, however, underestimate the time that may be required for debugged these systems.

Several of the systems (guide fields, chopper, spin flipper, beam monitors, ^{3}He polarizer) are either completed or well along in terms of their construction. Some of the larger, more complicated components are not quite as far along (beamline, LH_2 target, detector, and most notably the cave), but one is hopeful that with a more concerted effort, they will show additional progress in upcoming months and be ready for commissioning in 7/2003.

It was very encouraging to see the asymmetry measurements done in Cl. It demonstrates that several of the important technologies and systems have been tested."

"The npdγ collaboration has made impressive technical gains. Key components of the beamline neutronics are in place or ready to be installed. A portion (10%) of the experimental apparatus was successfully used to measure large asymmetries in capture reactions with heavy nuclei (Lanthanum, Chlorine), thus testing many of the critical technologies. The pre-amplifier was tested and found to meet noise specs. Final versions of the preamplifier and S/D amplifier boards have been produced. A more complicated positionable integrated target/detector mounting stand was found to be needed and has been designed. The LH target has passed two safety reviews. The spin flipper was successfully tested; minor work remains to complete it. The polarizer system is nearly complete with two polarizers plus spares in hand and optimization of the system design ongoing. Beam monitors were tested in-beam. There appear to be no technical showstoppers for this experiment (with the exception of the FP11 magnet interference, discussed in more detail below).

A solution to the FP11 magnet interference does need to be found or npdγ will not work. The issue was identified by npdγ collaborators five years ago. An MOU was signed with LANSCE that lacked sufficient quantitative detail and was therefore, apparently, ignored. Passive shielding of the npdγ experimental cave has been shown to be infeasible and moving the cave away from the offending magnet is also not a possibility. The optimal solution is not something this reviewer feels qualified to comment on, but experts on the committee seemed sure that several solutions were possible. Apparently LANSCE is prepared to pay for the solution once they reach a technical decision on which solution to implement. npdγ collaborators are awaiting such a decision before making their own decision about cave construction – specifically the amount of magnetic shielding they will incorporate. This reviewer did not understand the linkage. The "heavy" cave provides grossly inadequate shielding, the "light" cave somewhat worse. Therefore, shielding local to the FP11 magnet must be employed. Any local shielding seemed sure to reduce the magnetic field at the npdγ apparatus sufficiently to allow the use of the "light" cave. It therefore seems that the "light" cave option should be implemented on the assumption that local shielding of the FP11 magnet will be implemented – of course pressure to ensure this shielding is implemented will need to be maintained. This course of action would greatly reduce the risk of yet additional schedule slippage."

"The other area of concern for this reviewer was lack of a decision on data acquisition hardware. Moore's law and the benefit of delaying such a decision as long as possible are understood. However, waiting a few months will not make a big difference in the

available hardware. And, on the other hand, having this hardware available a few months in advance will likely aid experimental start-up and jumpstart analysis efforts."

"The problem regarding the stray field from FP11 should be resolved with haste. It is holding up the cave design and is a bottleneck, which I tend to believe has the effect of slowing the effort in the other work packages because collaborators feel that they are not a critical path item. A technical solution is undoubtedly quite feasible. Given the amount of time that p($\vec{n}$,γ)D needs to run to achieve its statistical goal, I don't see any type of time-sharing as a desirable solution. Large amounts of shielding are not practical, and it seems that a fairly straightforward design to buck the field at the source would not be difficult to realize."

The feasibility and completeness of the budgets and schedules:

"The budget appears to be sufficient to bring the experiment on line as long as there is no significant cost to the project associated with the magnet shielding. The schedule is exceptionally tight. However, it does appear achievable as long as the magnet shielding problems associated with FP11 are solved. A rapid resolution of the FP11 issue is essential for achieving a first-phase physics result by the end of 2003. A delay in getting useful data in the next run cycle will be damaging to the morale of the group, and to the credibility of the project as a whole."

"The planned budgets for the experiment completion appear adequate. There appears to be sufficient contingency left to complete the experiment. However, the remaining contingency for the beam line appears thin. A cost over-run for the completion of the beam line is likely to occur. The Laboratory and the P-Division are to be commended for helping keep the experiment within the proposed costs, thus far. A potential cost risk is the technical solution for the stray field from FP-11.

The remaining schedule appears to be aggressive. It is unlikely that this experiment will be commissioned and operating in FY03 without a heroic effort on the part of the collaboration and the Laboratory. It is reasonable to expect that the experiment could be in full operation in FY04 with diligence by both the collaboration and the Laboratory. Even this schedule will require additional focus from the collaboration and timely deployment of LANSE technical resources. The Laboratory, P-Division and DOE should be aware that at least five years are likely to be required to commission and operate this experiment."

"Thanks to significant support from LANL and from a number of the collaborating institutions, the capital budget seems to be within the expected costs. However, considering the slippage from the original schedule and the additional contributions that have been needed, the true cost of this experiment is significantly more than originally projected.

The proposed assembly and testing schedule is extremely tight and there is a real danger that the experiment may not be ready in time for the next LANSCE beam cycle. The schedule has slipped in many areas although it hasn't yet had an adverse impact. However, available float seems to now be gone in most areas and it is likely, given the limited human resources, that further slipping will occur."

"Since the management plan for the project was completed, the construction and installation seems to be within budget. The collaboration is to be commended for their efforts to contain cost increases, by identifying funding sources within the member institutions to cover some overruns.

There appears to be a good chance to have the FP12 beam line and experiment commissioned and some data collected by the end of 2003. As this experiment is attempting to measure a very small asymmetry, it would not be surprising if modifications to some of the apparatus were required before the data taking runs in 2004 (or even perhaps 2005). The schedule for installation and testing of some of the hardware, notably the experimental cave and liquid hydrogen target, is rather aggressive even if a rapid decision is made about shielding for the FP11 superconducting magnet."

"Overall, the p(n,γ)D collaboration has done a good job of staying within their budget and making realistic assessments of the financial needs to complete the construction. There have been some notable cost over runs, but where these have encountered, they have done a commendable job covering these costs from alternate sources, in particular LANL LDRD funds and the NSF. Their estimates for completion seem reasonable.

The schedule has been more problematic. It is not unheard of in collaborations to use an ambitious schedule as a motivational tool, but it tends to create a chronic failure to meet schedules and hence the scheduling may not be taken seriously by collaborators. DOE is becoming more aware of scheduling delays and concerned about their impact on the project. It may be useful for collaborations to reassess timelines. It may become more prudent to give realistic time estimates and impress upon the members the seriousness of the deadline rather than chronically missing an aggressive schedule."

"The Project Manager has implemented the recommended project management tools and has used them to manage the project. The project appears to be on-budget, at least as far as the DOE is concerned. However, the schedule for project completion has slipped considerably (almost a full year since the review one year ago). In this reviewer's opinion this is largely due to the lack of resolution to the interference with the FP11 magnet, which produces an unacceptable field at the npdγ apparatus. Since this drives the schedule for the construction of the cave (the project's critical path) there is little perceived schedule pressure on individual work package managers. This is unfortunate, because a complete apparatus, waiting to be installed, would surely increase pressure on the relevant parties to find a solution to the interference."

The effectiveness of the management structures:

"The management structure implemented after the last review is working well and has enabled the project manager to identify critical path schedule and budget issues within scope of the project. The new management at LANSCE appears to be very committed to the success of this project and the spirit of cooperation between LANSCE and Physics Divisions was gratifying to see."

"A reasonable management plan exists and the project manager seems extremely competent. Most of the scientists seem to have bought into the plan, but package leaders need to appreciate the importance of staying on schedule and working with project management. It would probably be useful for the management team to meet with the package leaders on a regular basis and for everyone to be more aware of the overall schedule."

"The management plan appears to be a useful management tool. The project manager has been effective in communicating with DOE and the collaboration. However, some of the subsystem managers for the experiment construction project did not appear to know that their part of the project was behind schedule. While this behavior, alone, did not delay the overall project during this period, a continuation of this lackluster performance would most certainly place the project in jeopardy during the coming year."

"The adoption of a management plan seems to have had a positive effect on this project. The positive attitude of the spokesperson and project manager to adopt the management tools used by large DOE-NP projects is to be commended."

"The project management is doing a good job at following the DOE prescription for its management plan. As noted, however, the project manager and work package leaders should place more emphasis on staying on schedule in all aspects of the project. I would emphasize that the work package leaders can be very helpful in keeping the overall project on track even though their particular work project may not be a critical path item at the time.

I note that the management leaders are also some of the key technical and scientific people, and it is important to minimize the administrative burden on them to allow them to put a greater fraction of their time into the implementation of the experiment.

The support of P Division and LANSCE management is greatly appreciated and absolutely necessary. It was particularly encouraging to hear the support from LANSCE senior management for the both the p(n, γ)D and UCNA experiments. It is important for the collaborations to feel that the fundamental physics program is integrated into LANSCE operations as a valuable asset to their mission and not as a distraction."

"It is strongly encouraged that np$\rightarrow$dγ collaborators, and P Division and LANSCE management work together to accomplish the goals of this project in a timely fashion. This is especially important for difficult experiments, such as this one, which often have challenging technical requirements (small magnetic fields, etc.)."

"As recommended in the panel closeout, the p(n̲,γ)D, P Division, and LANSCE management should immediately implement a mutually acceptable plan to resolve the FP11 and FP12 magnet shielding issue. The plan should quantify the acceptable levels of stray fields and thus allow p(n, γ)D to design and implement their detector cave expeditiously. This would remove a significant barrier to progress in all aspects of the experiment. "

Plans for commissioning and operation:

"The plans are well thought out, but given the complexity of the equipment, perhaps overly optimistic in regard to the feasibility of remote overnight operation. At least for the first running period, three shifts a day looks to be a necessity. The large amount of data may rapidly overwhelm the computing facilities being discussed for the experiment. While it's true that the analysis may be relatively straightforward once normal running conditions are established, it will be useful to establish data storage protocols early on so that multiple members of the collaboration can access the data remotely, and carry through analyses of systematic effects independently.

Use of an uninterruptable power supply for the hydrogen target has apparently been discussed, but is not being implemented. Operating the target with a UPS would allow experimenters to have confidence in the state of the target during a short or long power outage. This seems like a valuable feature, and essential if the planned remote operation is in fact implemented in the future."

"Clearly a substantial amount of work remains for commissioning, operation, and analysis. Based on the level of detail of the documentation it is apparent that that most effort is now aimed at putting the apparatus together. The collaboration should appoint a commissioning manager, to optimize and coordinate their very aggressive installation and commissioning plan.

Given the demands of construction, there seem to be the not unexpected manpower shortages with analysis. A bit disturbing during our discussions was the general approach and attitude to the analysis, in particular when compared to other precision experiments, for example the muon g-2 experiment. The collaboration is very resistant to considering current accepted analysis practices such as "blind analysis". There were a number of very worrisome comments about using the data to find systematic problems. This can be done, but one must take great care to avoid introducing bias into the result. The current approach may in the long run make the community less receptive to the collaboration's results. "

"The np→dγ collaboration is encouraged to consider appointing a commissioning leader to oversee this critical stage in the experiment, as it appears the project manager has many beam line tasks and problems with magnetic shielding and cave construction to deal with."

“The group is technically very strong, but could certainly use more help especially as it moves into the commissioning phase.”

“The draft plan for commissioning appears to be reasonably well thought out, however, the plan should be finalized. A time-line of the installation and commissioning shows many possible conflicts and very little float. A commissioning manager should be appointed by the collaboration to ensure adequate coordination of all the intricate interlocking activities associated with installing and commissioning this experiment.”

“The collaboration has carefully considered commissioning of the apparatus and many checks of hardware performance. As noted above, a commissioning leader in residence at Los Alamos for the spring and summer of 2003 would be helpful.

It was reported that researchers were expected to be present for only two 8-hour shifts per day during normal operations. This plan is not recommended, at least initially. Given the many tests for systematic effects and the aggressive schedule, beam time will be precious. Furthermore, safety concerns for liquid hydrogen targets at many laboratories usually lead to a requirement of at least one researcher present whenever a target is full.”

“The plans for commissioning the experiment are very ambitious, and it will be very difficult to meet those goals. As noted, all of the systems are making good progress and don't appear to have serious technical issues, but it will take much more effort in order to install and debug them on the beamline. There are many problems that will become apparent only when there are neutrons in the apparatus. This is understood, but it should be taken into account when making a schedule. The commissioning date of 07/2003 is quite aggressive.

The review panel's suggestion of appointing a commissioning manager is reasonable. He/she would have no additional administrative duties but has the responsibility to coordinate the installation and commissioning plan. The hope would be that it focuses the effort in a more efficient way.

It appeared that plans for manpower during operations was light. It may be the case that the apparatus runs maintenance-free at some point, but it is hard to imagine that all of the new and complicated subsystems won't require fairly intensive monitoring, particularly at the outset. The collaboration should plan, at least at the outset, to staff 24 h coverage to ensure the safe operation and efficient operation of the experiment.”

“This reviewer was somewhat concerned about the collaboration manpower which appeared thin given the aggressive commissioning schedule and the requirement of extended running time. The commissioning plan that was presented seemed very thorough. It seemed achievable in its present form, but only if everything works as expected. The collaboration has worked to ensure this, but rare indeed is the experiment that comes together as expected. Slippage here (especially if there is additional slippage due to lack of resolution to the FP11 magnet issue) would put the project at risk of collecting no physics data during the next LANSCE operation cycle. The operations plan

calls for only manning two shifts – on its surface, such a plan seems unlikely to win safety approval given the presence of a liquid hydrogen target. More graduate students would help (as was noted by the committee), so would recruitment of additional collaborators. Complete focus on this experiment by the LANL principals would also help – although telling top-notch scientists that they cannot think about future experiments does not seem like a reasonable thing to do."

"The manpower for the installation, commissioning and operation of this experiment appears to be thin. It seems unlikely that with the installation of a new cryotarget that the collaboration will only operate two shifts per day intitially. Moreover, staffing three shifts per day during commissioning would be make more efficient use of the beam time. The collaboration should make every effort to add graduate students to the project as well as focus more of their attention on this project."

Other issues related to the neutron experiments and their experimental program:

"Finally, the importance of systematic errors seems to be fully appreciated by the npdγ collaborators and this reviewer was impressed by the efforts taken to think of and reduce/eliminate sources of such errors. They also seem to recognize that they will almost certainly not think of everything and have designed in a variety of experimental handles that they can use to identify such errors. For instance, the pulsed nature of LANSCE gives them a polarization that varies as a function of neutron time-of flight - any real effect will have the same functional form. The pulsed nature and a clever chopper and data acquisition strategy allows them to measure, continuously, beam-off backgrounds and beam-on backgrounds without any polarization."

"Overall the npdγ collaboration is a very bright and talented group of scientists. Given the priority and financial support this experiment has received from both the DOE and Los Alamos, and taking into consideration the slippage in the originally proposed schedule (1998 proposal), it is critically important that the npdγ collaboration concentrate as much as possible on bringing this experiment to fruition. The committed manpower appears thin given the remaining tasks. A particular concern is that many of the senior scientists are involved in other projects that are diluting their npdγ efforts. The group needs to realize that future experiments are linked to the current efforts, both from the standpoint of available resources and because the group's future proposals will be considered in light of the success of the npdγ project. In the larger context off the overall US program, the delays in constructing this project and the fact that longer running times will be required will likely delay or even endanger other worthwhile projects. It is hence strongly recommended that the key personnel focus a larger fraction of research time to this project."